CableWISE

A SERVICE OF TECHIMP

Cable System Condition Assessment Report

Provided For:
Electric Utility

Location:
URD and Feeder Cable System

Date: 2016

Report #: Sample

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Introduction

A CableWISE® Online Cable System Condition Assessment was performed for *Electric Utility Customer* in *Location* at *Area* by Techimp USA Corporation. Data acquisition at selected cables on site for the Online Condition Assessment was performed on *Date*.

Summary

The Online Condition Assessment displays the results of the analysis by categorizing the findings into five Levels with Level 5 having the worst condition. Definitions for the Levels and recommended actions are listed in Table 1 on page 5. The CableWISE® Technology allows for an individual evaluation of the cable segments and accessories.
Summarized test results are shown below in Figure 1 for the 58 single-phase cable segments tested at a total of 27,142 circuit feet with separate findings for the 116 accessories, in this case the cable terminations. Results by individual segment are listed in Table 3 starting on page 7.

The one-line diagrams of tested areas starting on page 10 better illustrate the physical location of the tested segments with the color-coded results.

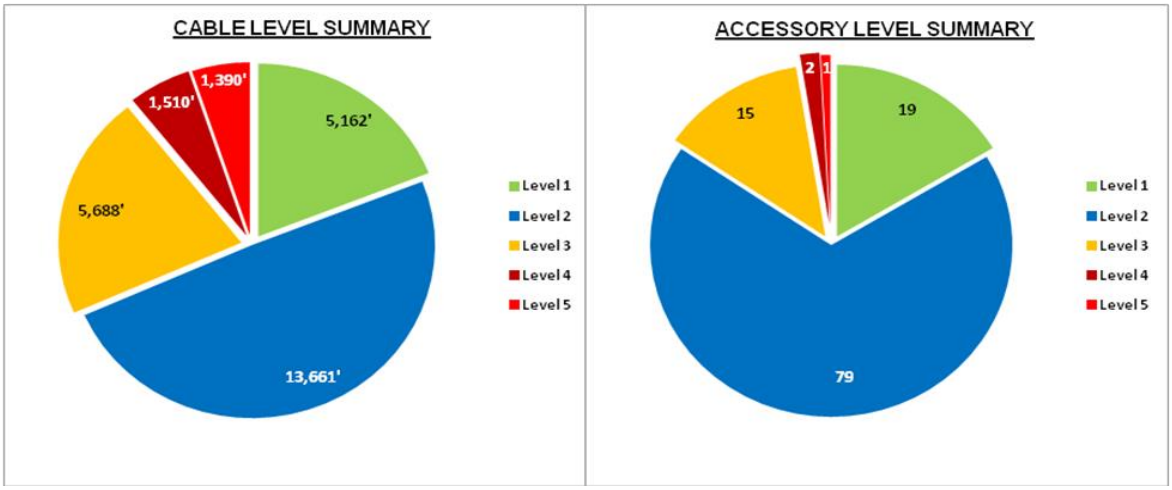


Figure 1: Test results in single-phase circuit feet for Cables and by quantity for Accessories

One of the tested cable sections in URD Loop 1 (between Transformers T-104 to T-105) displayed strong discharge signals and was assigned a Level 5, as well as the three-phase section of Feeder 4 (between Junction box J-406 and J-407). One elbow termination at Transformer T-202 also received the Level 5 rating. It is recommended to replace these components.

The cable section at URD Loop 1 (between T-104 and T-105) and at Feeder 3 (A-Phase from S-302 to J-303) displayed discharge signals and was assigned a Level 4, as well as the elbow termination in URD Loop 2 at T-208 and another elbow termination in Feeder 4 at S-404. It is recommended to either replace these components or re-test within one year.

A total of twelve cable sections and 15 accessory point locations showed some aging related discharges and were assigned a Level 3. It is recommended to proactively re-test these within two years to establish trending information.

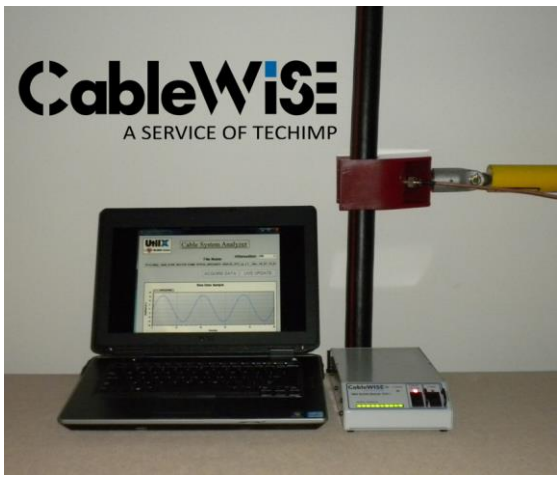
All remaining components display small or no aging related signals consistent with a Level 2 or Level 1 rating. No immediate action is required for these components.

This CableWISE® assessment report represents Techimp's best efforts in determining the condition of the cable system from data gathered at a single point in time. It should be noted that events can occur that may alter these findings; therefore, the persons receiving this report must make their own determination as to its suitability for their purposes prior to use or reliance in connection with the making of any decision.

Procedure

Partial discharge creates RF signals which are attenuating along the cable system while in service and are detected with a capacitive sensor that is placed over the shielded part of a cable (Figure 2). The data acquisition equipment synchronizes the signals to the frequency of the system under test and then records them in digital format for later processing and analysis on a laptop computer. Techimp Analysts then determine the condition of the cable system, including all cable sections and their associated splices and terminations. Since the data acquisition is performed on-line and with all components energized under normal operating conditions, the assessment also includes transformers and switchgear attached to the cable system. Switching operations and disconnecting of cables is not required.

Typical Sensor attached to cable



Data acquisition equipment

Figure 2: Typical data acquisition setup

To determine the type of deterioration and location of the defect our analysts are considering the signal intensity, phase angle, signature, pulse repetition, synchronicity with AC cycle and frequency at which the signal occurs (Figure 3). The assessed condition of each component also depends on the type of cable insulation, type of installation, service age, and previous condition assessments (when available).

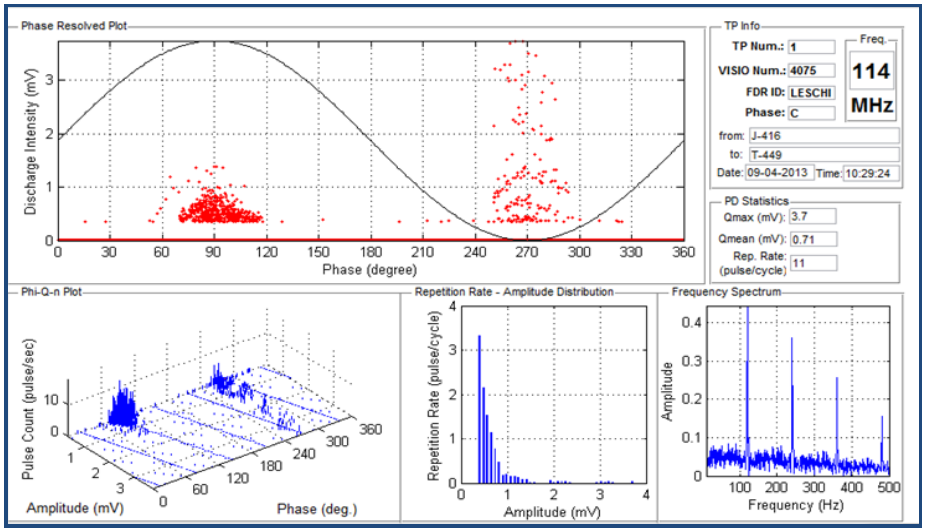


Figure 3: Typical RF signal phase resolved trace in time domain.

Table 1: Condition Level Definitions for Cables, Splices, Terminations and Equipment

Level 1	The system is not degraded. No action is required.
Level 2	There is a small amount of aging related signals. No immediate action is required.
Level 3	Cable System shows recognizable aging related signals with a low to moderate level of deterioration. System has a low probability of failure. Recommendations: Cable: Proactively re-test within two years to establish trending information. *Optional: Rejuvenate the cable.* Accessory: Proactively re-test within two years to establish trending information.
Level 4	Cable System shows aging related signals with a moderate to high level of deterioration. System has a medium probability of failure. Further discussion is required to determine the viability of rejuvenation or replacement. Recommendations: Cable: Replace or re-test within one year. *Optional: Rejuvenate the cable.* Splice/Joint: Replace or re-test within one year. Termination/Equipment: Option 1: Clean and check termination/equipment. Examine the outer surface for signs of tracking. Clean the outer surface of the termination. Re-examine for tracking after cleaning. Check that termination connector is properly attached (compressed) on the cable conductor. Check that the connection between the connector and the equipment bushing is properly tightened. Re-assess termination/equipment. Option 2: Replace termination/equipment.
Level 5	Cable System shows intense aging related signals. System is at the end of economic life and has a high probability of failure. Immediate attention is recommended. Recommendation: Cable: Replace immediately. Joint: Replace immediately (for all types of cable). Termination/Equipment: Option 1: Clean and check termination/equipment. Examine the outer surface for signs of tracking. Clean the outer surface of the termination. Re-examine for tracking after cleaning. Check that termination connector is properly attached (compressed) on the cable conductor. Check that the connection between the connector and the equipment bushing is properly tightened. Re-assess termination/equipment. Option 2: Replace termination/equipment.
HBI	High Background Interference refers to strong interference, external to the cable system. This interference cannot be mitigated.
RAR	Retest After Repair and refers to strong interference emanating from within the cable system or near the test area. It is recommended to repair the problematic components to mitigate the interference and retest.
N/A	Not applicable, no splice (joint) next to sensor or cable section already diagnosed in previous entry.

Results Table

Results of the Online Condition Assessment data analysis for the cable sections assessed and their accessories are given in **Table 3 starting on page 12.**

Table 2: Legend for Table of Results

Column name	Description
Test Date	Date of assessment
TP #	Test point number (point of attachment number) followed by unique test identification number after a dash.
Test From	Point of attachment for sensor and beginning of cable section
Test To	End of cable section
Phase	Cable Phase
Length (ft)	Length of cable section
Insltn. Type	Insulation type or material
Cond. Type	Type of conductor construction
Cond. Mat'l	Conductor material
Cond. Size	Conductor size
Jacket	Presence of a protective cable jacket (underground installations)
Installation	Installation type
Jacket	Presence of a protective cable jacket (underground installations)
OP. Voltage	Cable operating voltage
Vintg.	Manufacturing year as marked on cable jacket or approximate year of installation
Diagnosis Cable	Condition assessment Level for the cable section defined between "Test From" and "Test To".
Diagnosis Accessory From	Condition assessment Level for the accessory located at location stated by "Test From"
Diagnosis Accessory To	Condition assessment Level for the accessory located at location stated by "Test To"
Comments	Comments concerning condition assessment (Level).

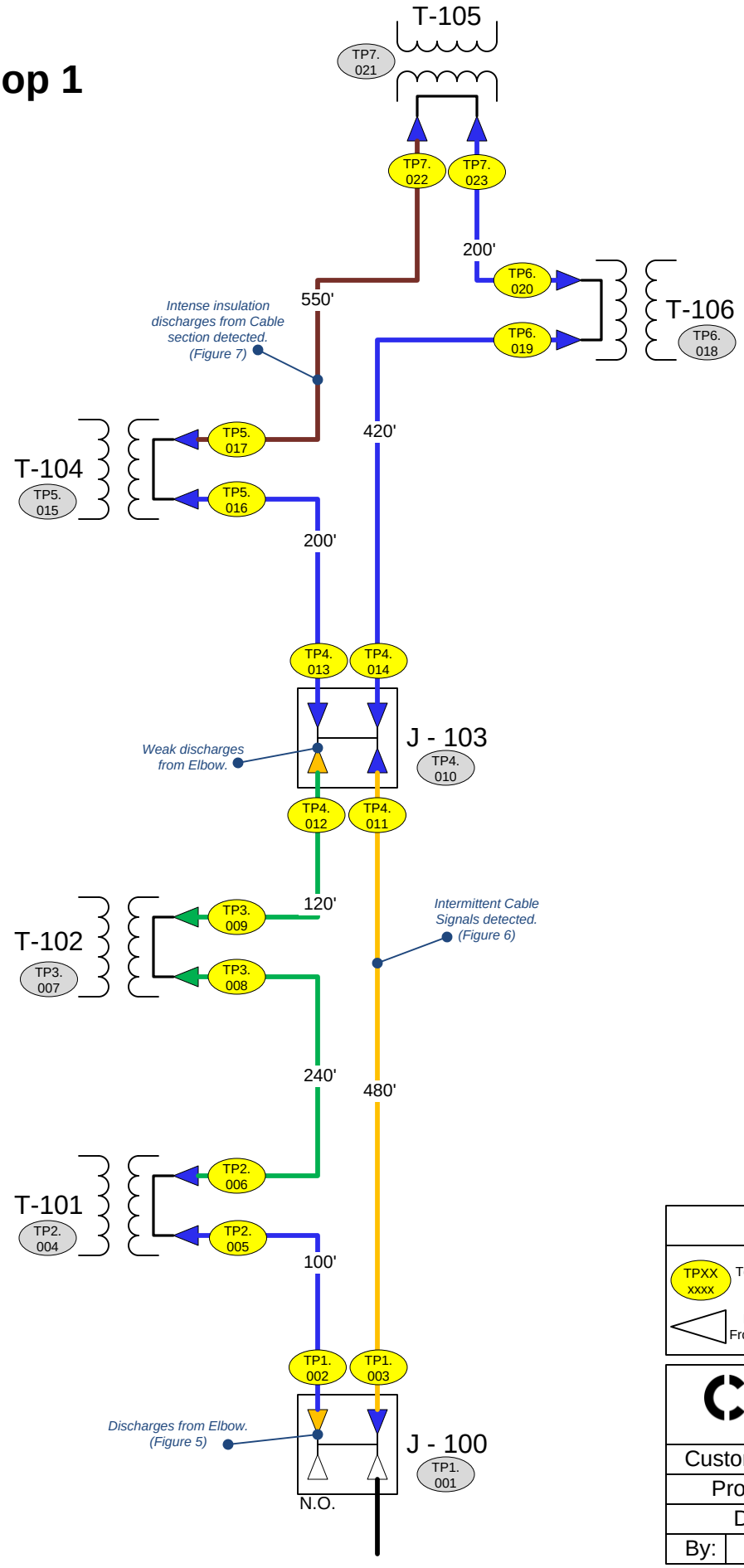
Result Table: Sample Report

Test Date	TP#	Test From:	Test To:	Phase	Length (ft)	Insltn. Type	Cond. Type	Cond. Mat'l	Cond. Size	Jacket	Installation	Op. Voltag e	Vintage	Diagnosis Cable	Diagnosis Accessory From	Diagnosis Accessory To	Comment
URD Loop 1																	
mm-dd-yy	1.002	J-100	T-101	A	100	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 2	Level 3	Level 2	Termination discharges detected. Refer to Figure 5.
mm-dd-yy	2.006	T-101	T-102	A	240	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 1	Level 2	Level 1	
mm-dd-yy	3.009	T-102	J-103	A	120	XLPE	3C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 1	Level 1	Level 3	Weak discharges from Elbow.
mm-dd-yy	4.013	J-103	T-104	A	200	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 2	Level 2	Level 2	
mm-dd-yy	5.017	T-104	T-105	A	550	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 4	Level 2	Level 2	Intense discharges from cable section. Refer to Figure 7.
mm-dd-yy	7.023	T-105	T-106	A	200	XLPE	3C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 2	Level 2	Level 2	
mm-dd-yy	6.019	T-106	J-103	A	420	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 2	Level 2	Level 2	
mm-dd-yy	4.011	J-103	J-100	A	480	XLPE	1C	CU	#2 AWG	NO	DIRECT BURIED	14.4	1983	Level 3	Level 2	Level 2	Intermittent cable signals. Refer to Figure 6.
URD Loop 2																	
mm-dd-yy	8.025	J-200	J-201	C	174	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1972	Level 3	Level 2	Level 2	
mm-dd-yy	14.046	J-201	T-202	C	223	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1972	Level 3	Level 2	Level 5	Strong discharges from elbow. Refer to Figure 8.
mm-dd-yy	15.049	T-202	T-203	C	732	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1972	Level 2	Level 3	Level 2	
mm-dd-yy	16.053	T-203	T-204	C	400	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1972	Level 2	Level 2	Level 2	
mm-dd-yy	16.052	T-203	T-205	C	621	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1971	Level 2	Level 2	Level 2	
mm-dd-yy	17.056	T-205	T-206	C	259	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1971	Level 2	Level 2	Level 2	
mm-dd-yy	18.059	T-206	T-207	C	450	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1971	Level 2	Level 2	Level 2	
mm-dd-yy	20.064	T-207	J-201	C	625	XLPE	1C	AL	1/0 AWG	NO	DIRECT BURIED	14.4	1971	Level 5	Level 2	Level 3	Strong cable signals detected. Refer to Figure 10.
mm-dd-yy	14.044	J-201	T-208	C	96	EPR	1C	CU	1/0 AWG	YES	INSULATED CONDUIT	14.4	2006	Level 2	Level 3	Level 2	
mm-dd-yy	13.040	T-208	T-209	C	647	EPR	1C	CU	1/0 AWG	YES	INSULATED CONDUIT	14.4	2006	Level 2	Level 4	Level 2	Tracking discharges from elbow. Refer to Figure 9.
mm-dd-yy	12.037	T-209	T-210	C	196	EPR	1C	CU	1/0 AWG	YES	INSULATED CONDUIT	14.4	2005	Level 1	Level 2	Level 1	
mm-dd-yy	11.034	T-210	T-211	C	84	EPR	1C	CU	1/0 AWG	YES	INSULATED CONDUIT	14.4	2005	Level 1	Level 1	Level 1	
mm-dd-yy	10.031	T-211	T-212	C	447	XLPE	1C	AL	1/0 AWG	YES	INSULATED CONDUIT	14.4	2005	Level 2	Level 2	Level 1	
mm-dd-yy	9.028	T-212	J-200	C	222	XLPE	1C	AL	1/0 AWG	YES	INSULATED CONDUIT	14.4	2005	Level 1	Level 1	Level 2	

Test Date	TP#	Test From:	Test To:	Phase	Length (ft)	Insltn. Type	Cond. Type	Cond. Mat'l	Cond. Size	Jacket	Installation	Op. Voltage	Vintage	CableWISE Diagnosis			Comment
														Cable	Accessory From	Accessory To	
Feeder 3																	
mm-dd-yy	27.105	PR-301	S-302	A	130	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 3	Level 3	Level 3	
mm-dd-yy	27.106	PR-301	S-302	B	130	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 3	Level 3	Level 3	
mm-dd-yy	27.107	PR-301	S-302	C	130	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 2	Level 2	Level 3	
mm-dd-yy	26.098	S-302	J-303	A	960	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 4	Level 2	Level 2	Cable signals detected. Refer to Figure 11.
mm-dd-yy	26.099	S-302	J-303	B	960	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 3	Level 2	Level 2	
mm-dd-yy	26.100	S-302	J-303	C	960	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1996	Level 3	Level 2	Level 2	
mm-dd-yy	25.091	J-303	S-304	A	650	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	1999	Level 2	Level 2	Level 2	
mm-dd-yy	25.092	J-303	S-304	B	650	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2000	Level 2	Level 2	Level 2	
mm-dd-yy	25.093	J-303	S-304	C	650	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2001	Level 2	Level 2	Level 2	
mm-dd-yy	24.084	S-304	J-305	A	450	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 2	Level 3	Level 2	
mm-dd-yy	24.085	S-304	J-305	B	450	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 2	Level 2	Level 2	
mm-dd-yy	24.086	S-304	J-305	C	450	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 2	Level 2	Level 2	
mm-dd-yy	23.077	J-305	J-306	A	860	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 1	Level 2	Level 1	
mm-dd-yy	23.078	J-305	J-306	B	860	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 1	Level 2	Level 1	
mm-dd-yy	23.079	J-305	J-306	C	860	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 1	Level 2	Level 1	
mm-dd-yy	21.071	J-306	T-307	A	268	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 1	Level 1	Level 2	
mm-dd-yy	21.070	J-306	T-307	B	268	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 2	Level 1	Level 2	
mm-dd-yy	21.069	J-306	T-307	C	268	XLPE	1C	AL	500KCMIL	YES	DIRECT BURIED	14.4	2003	Level 2	Level 1	Level 2	

Test Date	TP#	Test From:	Test To:	Phase	Length (ft)	Insltn. Type	Cond. Type	Cond. Mat'l	Cond. Size	Jacket	Installation	Op. Voltag e	Vintage	CableWISE Diagnosis			Comment
														Cable	Accessory From	Accessory To	
Feeder 4																	
mm-dd-yy	28.109	S-401	J-402	A	895	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 2	Level 2	Level 2	
mm-dd-yy	28.110	S-401	J-402	B	895	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 2	Level 2	Level 2	
mm-dd-yy	28.111	S-401	J-402	C	895	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 2	Level 2	Level 3	
mm-dd-yy	29.116	J-402	J-403	A	484	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 1	Level 2	Level 1	
mm-dd-yy	29.117	J-402	J-403	B	484	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 1	Level 2	Level 1	
mm-dd-yy	29.118	J-402	J-403	C	484	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	2001	Level 1	Level 2	Level 1	
mm-dd-yy	30.123	J-403	S-404	A	770	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 2	Level 1	Level 2	
mm-dd-yy	30.124	J-403	S-404	B	770	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 3	Level 1	Level 4	Termination signals observed. Refer to Figure 12.
mm-dd-yy	30.125	J-403	S-404	C	770	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 2	Level 1	Level 2	
mm-dd-yy	31.130	S-404	J-405	A	515	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 3	Level 2	Level 2	
mm-dd-yy	31.131	S-404	J-405	B	515	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 3	Level 2	Level 2	
mm-dd-yy	31.132	S-404	J-405	C	515	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 3	Level 2	Level 2	
mm-dd-yy	32.137	J-405	J-406	A	315	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 2	Level 2	Level 2	
mm-dd-yy	32.138	J-405	J-406	B	315	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 2	Level 2	Level 2	
mm-dd-yy	32.139	J-405	J-406	C	315	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 3	Level 2	Level 2	
mm-dd-yy	33.144	J-406	J-407	A	255	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 5	Level 2	Level 3	
mm-dd-yy	33.145	J-406	J-407	B	255	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 5	Level 2	Level 3	Intense insulation discharges from cable section in all phases. Refer to figure 13.
mm-dd-yy	33.146	J-406	J-407	C	255	XLPE	1C	AL	250KCMIL	YES	DIRECT BURIED	14.4	1989	Level 5	Level 2	Level 3	

URD Loop 1



Legend

TPXX XXXX — Test Point from Sensor End	Level 5
	Level 4
	Level 3
Elbow or Life Front Termination	Level 2
	Level 1

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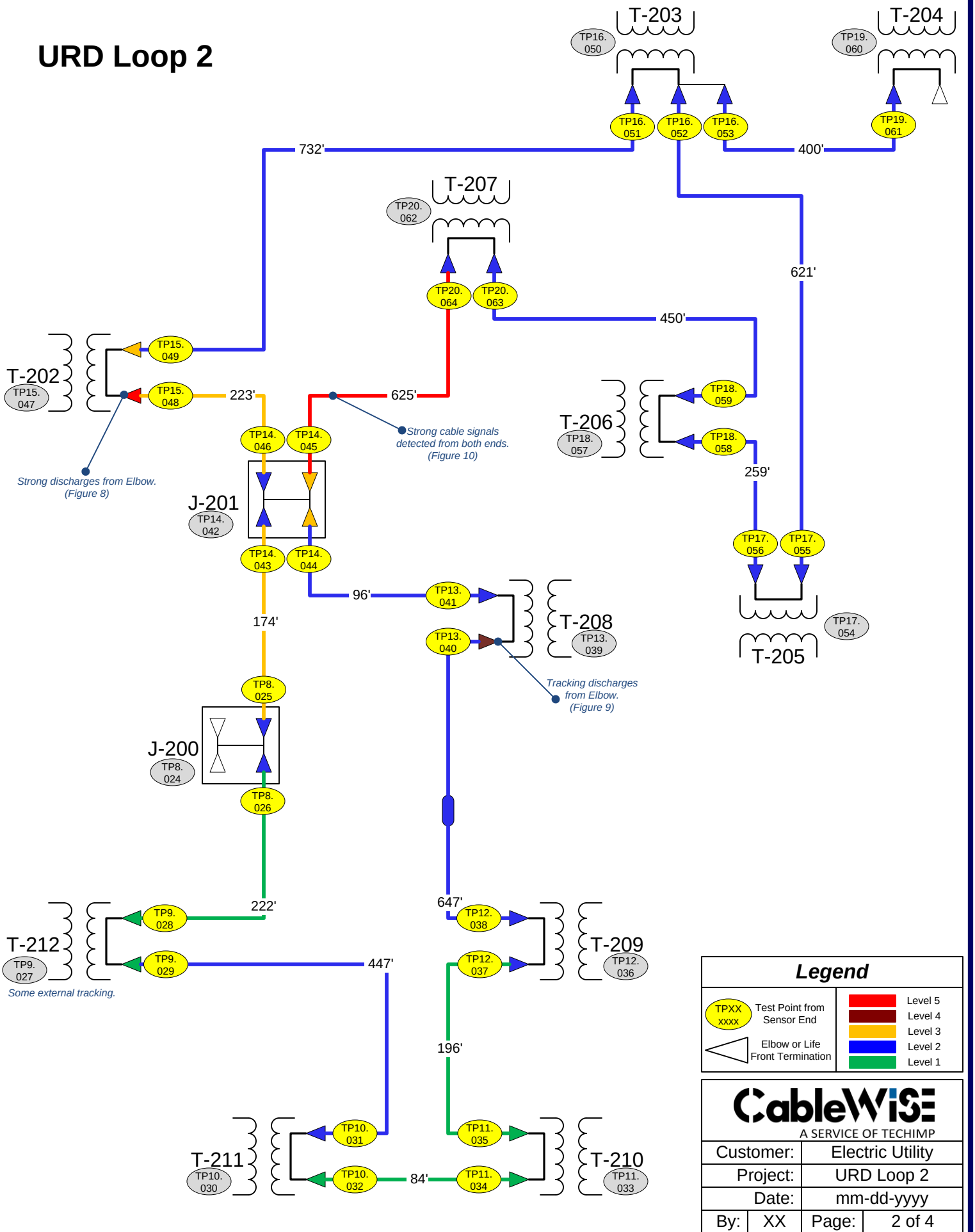
Customer:		Electric Utility	
Project:		URD Loop 1	
Date:		mm-dd-yyyy	
By:	XX	Page:	1 of 4

URD Loop 2



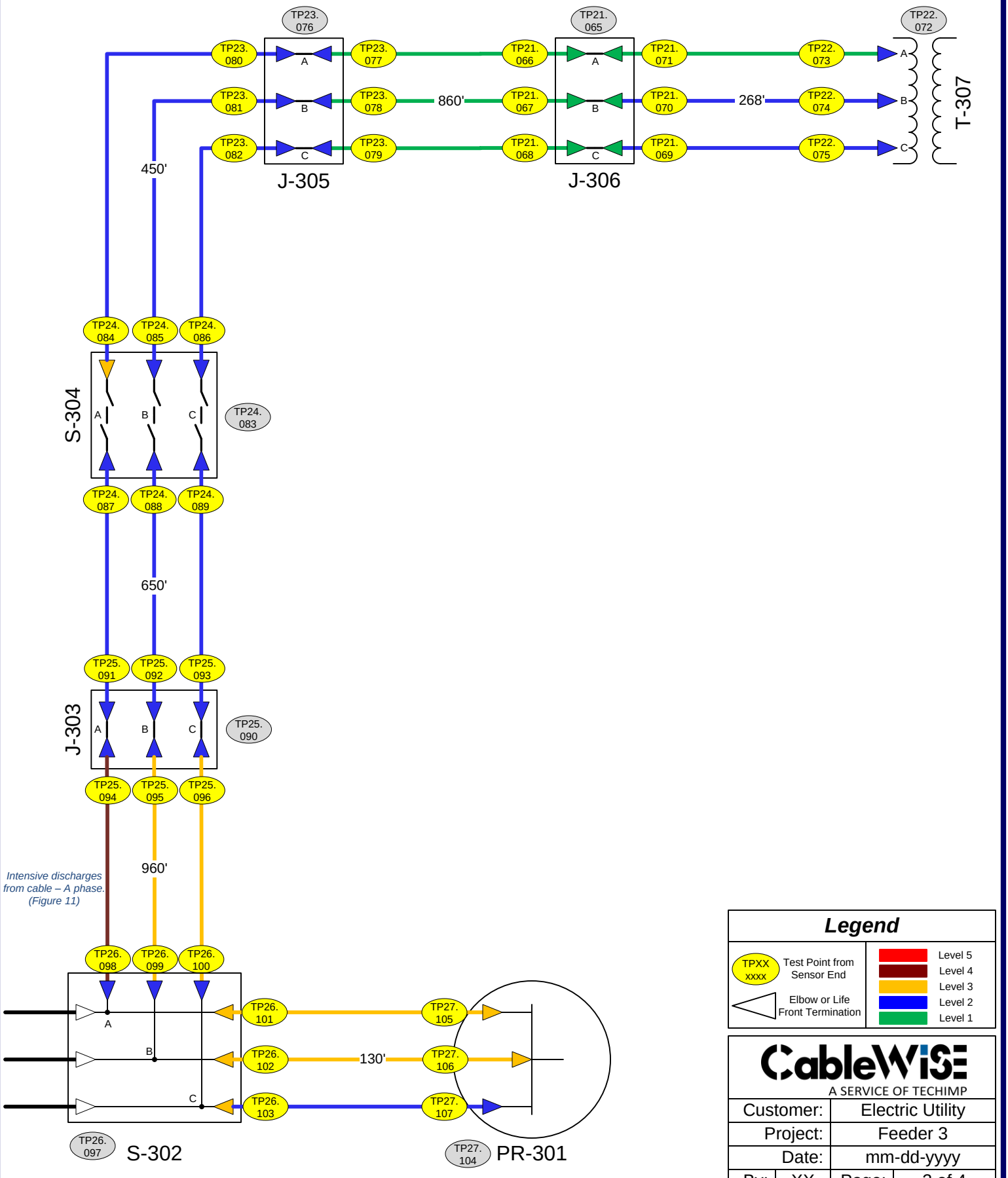
Legend

TPXX xxxx — Test Point from Sensor End	Level 5
	Level 4
	Level 3
Elbow or Life Front Termination	Level 2
	Level 1

CableWiSE
A SERVICE OF TECHIMP

Customer:	Electric Utility		
Project:	URD Loop 2		
Date:	mm-dd-yyyy		
By:	XX	Page:	2 of 4

Feeder 3



Legend

TPXX xxxx — Test Point from Sensor End	Level 5
	Level 4
	Level 3
Elbow or Life Front Termination	Level 2
	Level 1

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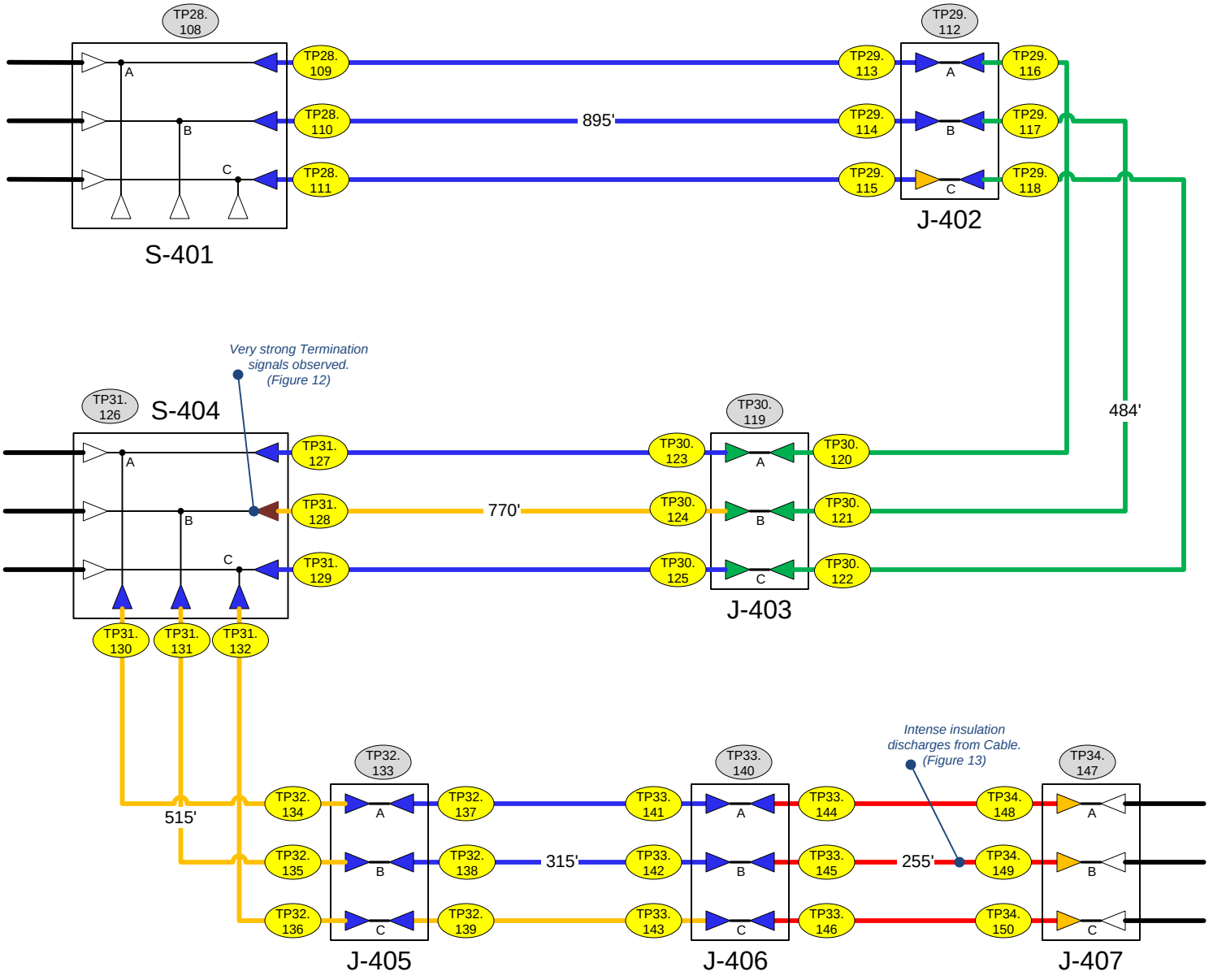
Customer:	Electric Utility		
Project:	Feeder 3		
Date:	mm-dd-yyyy		
By:	XX	Page:	3 of 4

Feeder 4



Legend

TPXX xxxx — Test Point from Sensor End	Level 5
Elbow or Life Front Termination	Level 4
	Level 3
	Level 2
	Level 1

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Customer:	Electric Utility		
Project:	Feeder 4		
Date:	mm-dd-yyyy		
By:	XX	Page:	4 of 4

Figure 4: Content

Plots 1 thru 4 as shown on this Figure correspond to:

1) Cumulative zero span data at a center frequency, shown in “Freq.” tab in right (024 MHz). The data include one second of sampling containing 60 (or 50) power frequency cycles.

2) Φ-Q-n plot gives the relation among the power frequency phase angle (Φ), discharge amplitude (Q) in the unit of mV, and the number of discharges in the unit of pulse per second (n).

3) Repetition rate versus PD amplitude plot, which gives repetition rate as a function of pulse amplitude. The PD repetition rate is represented by pulse per cycle.

4) Repetition frequency of 1) calculated from a Fourier transform.

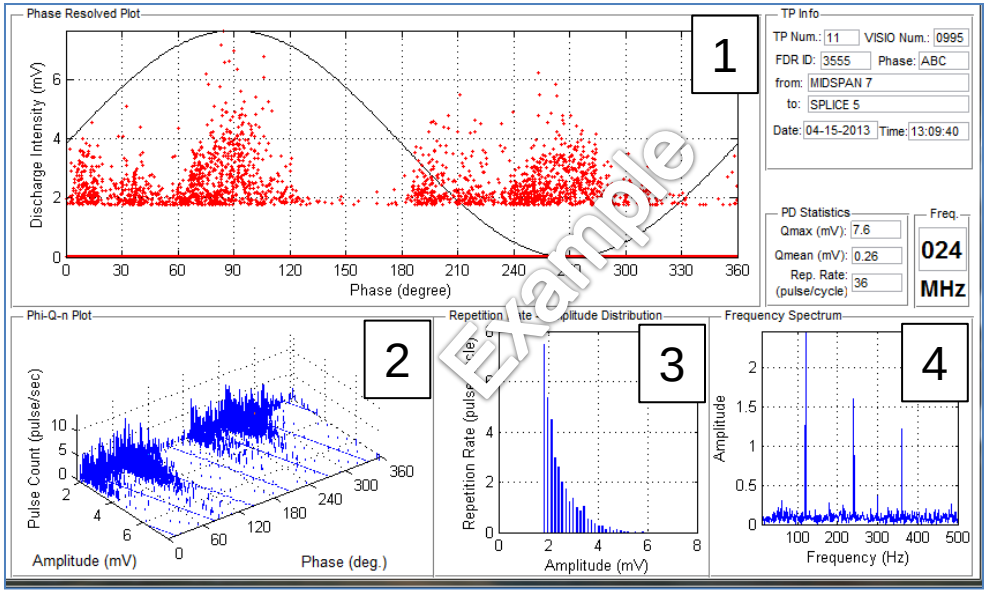


Figure 5.
URD Loop 1
TP1.002
Termination at J-100 to T-101

Level 3 Termination

Discharges observed from cable termination.

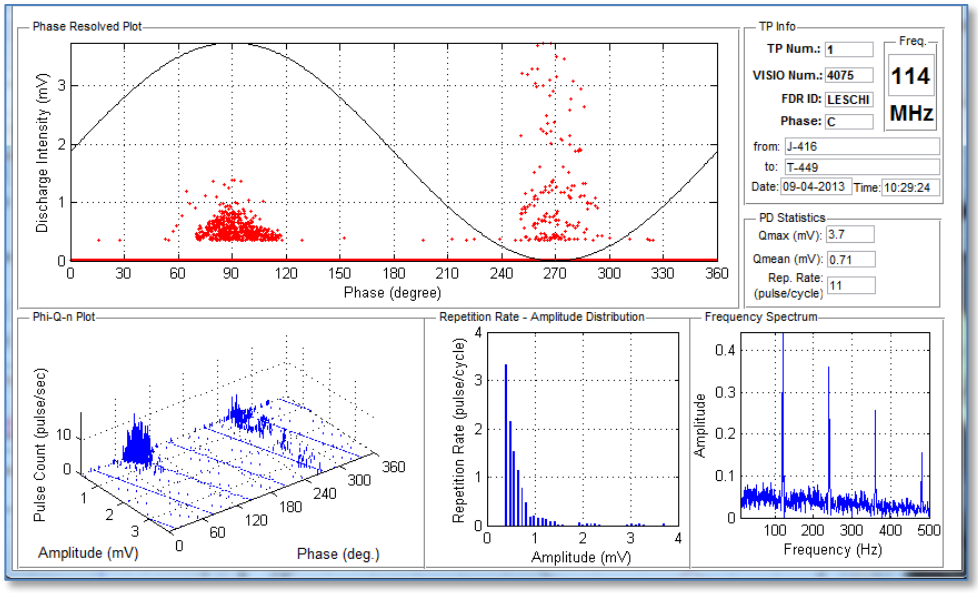


Figure 6.
URD Loop 1
TP4.011
Cable from J-103 to J-100

Level 3 Cable

Intermittent cable signals detected.

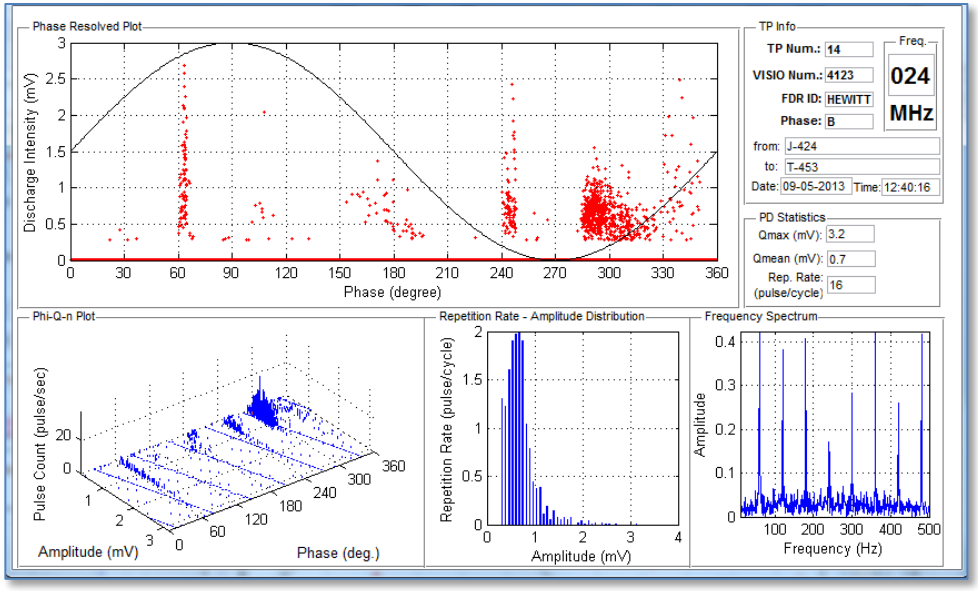


Figure 7.
URD Loop 1
TP5.017
Cable from T-104 to T-105

Level 4 Cable

Intense discharges are observed from this cable section. The signals were in a much smaller amplitude at T-105 possibly due to serious neutral corrosion.

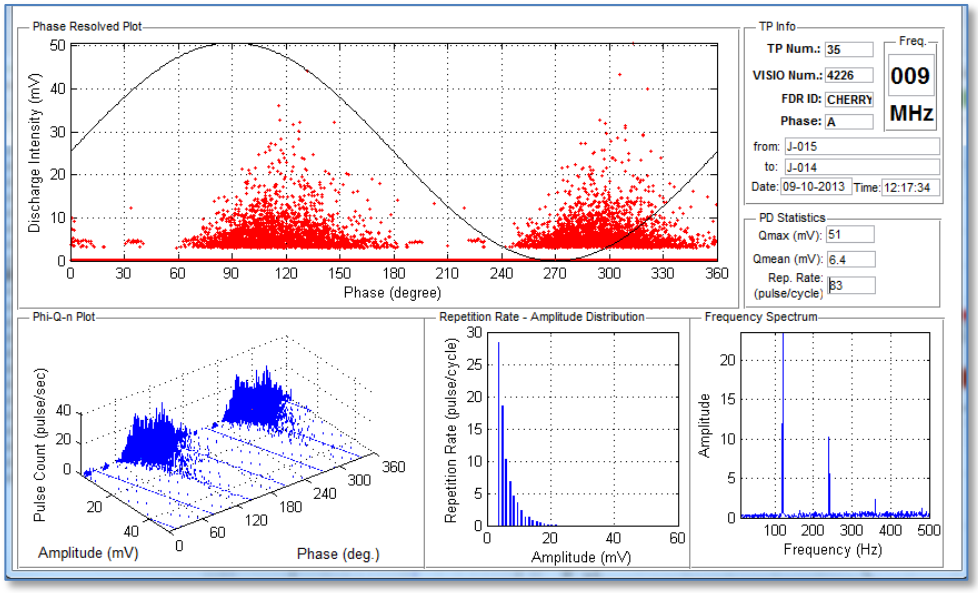


Figure 8.
URD Loop 2
TP15.048
Elbow at T-202 to J-201

Level 5 Termination

Strong termination discharges detected.
The attached cable could be better than a Level 3 due to the intensity of these discharges.

It is recommended to replace this Elbow Termination.

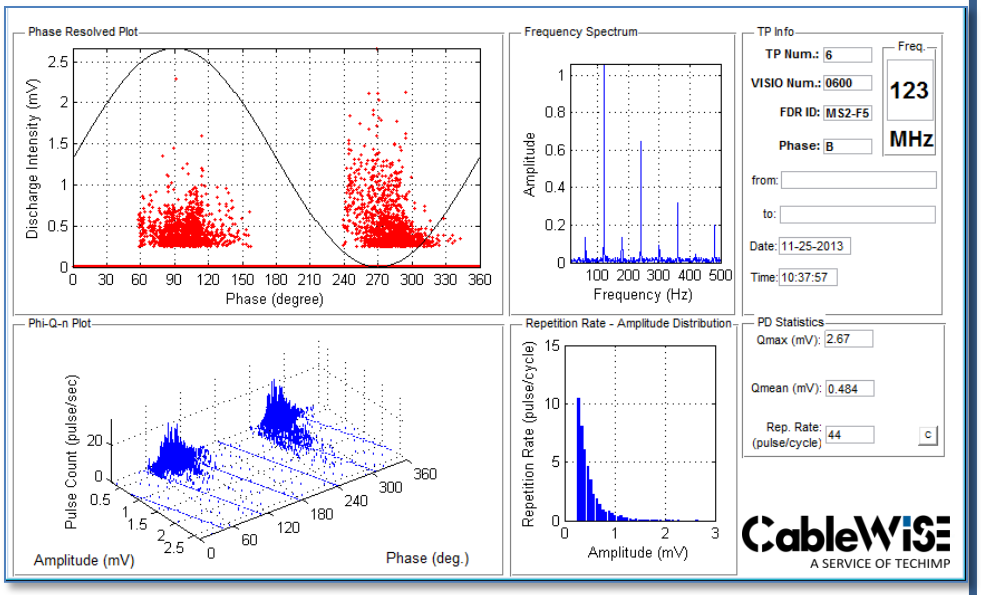


Figure 9.
URD Loop 2
TP13.040
Elbow at T-208 to T-209

Level 4 Termination

Strong tracking discharge from elbow termination detected.

It is recommended to replace this elbow termination.

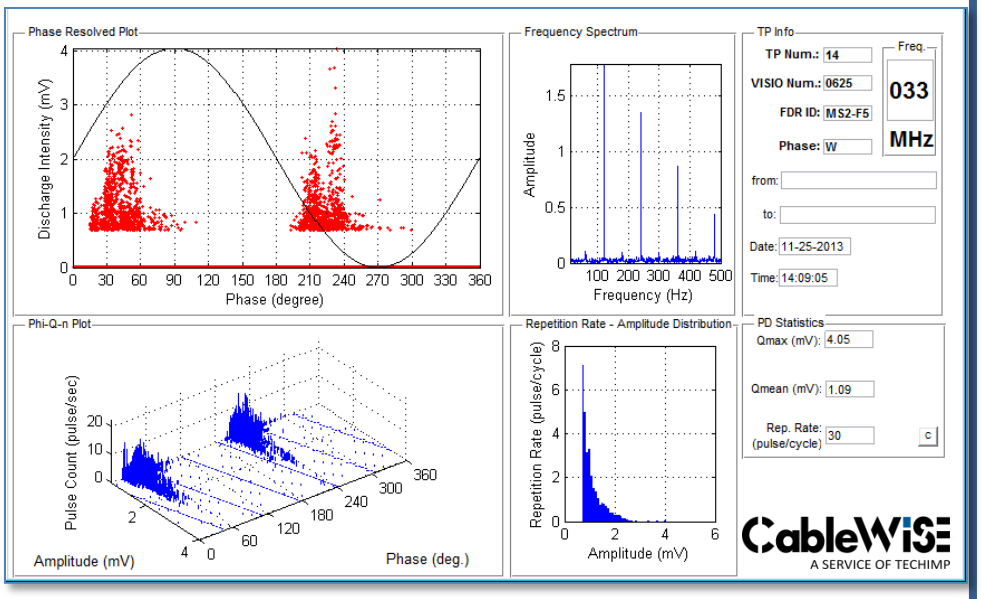


Figure 10.
URD Loop 2
TP14.045
Cable section from J-201 to T-207

Level 5 Cable

Very Strong discharges from cable section detected. Signal also confirmed from the other end at TP 20.064.

It is recommended to replace this cable section.

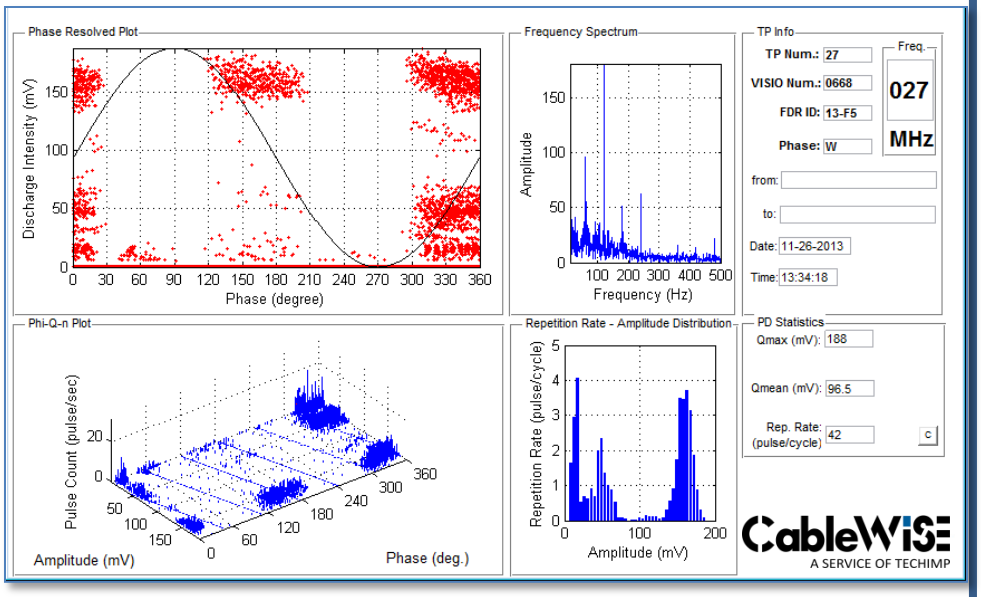
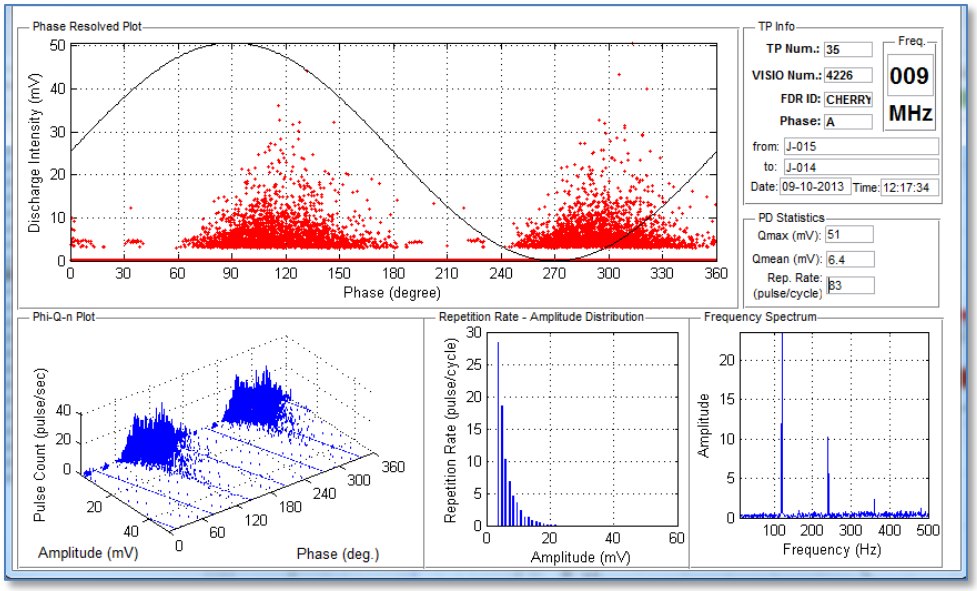


Figure 11.
Feeder 3
TP26.098
Cable section from S-302 to J-303
A-Phase

Level 4 Cable

Intense discharges are observed from cable section. The signals were detected at both ends S-302 and J-303. Strongest signal detected in A-phase.



Signal display to the right is taken from J-303

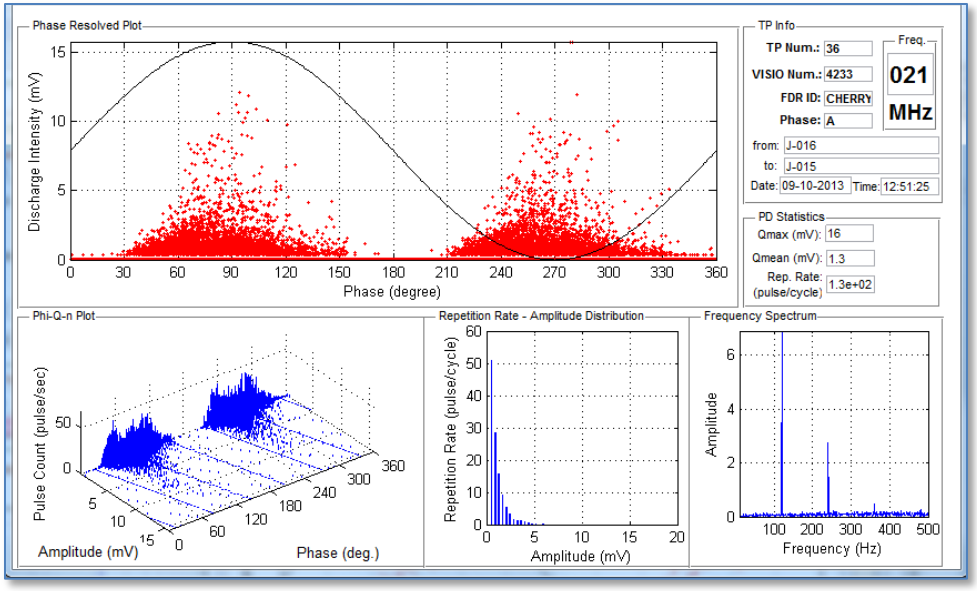


Figure 12.
Feeder 4
TP31.128
Elbow at S-404 to J-403
B-Phase

Level 4 Termination

Strong tracking discharges observed at this phase from cable termination, which could come from the bushing.

The attached cable could be better than a Level 3 due to the intensity of these discharges.

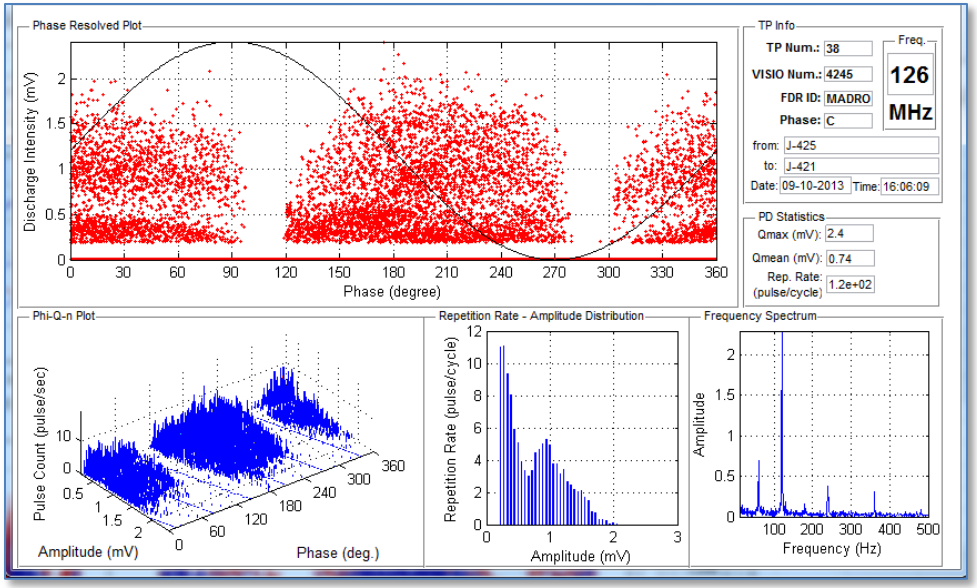


Figure 13.
Feeder 4
TP34
Cable section from J-407 to J-406, All Phases

Level 4 Cable

Intense discharges are observed from this cable section. Could not determine the exact Phase.